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Original Article

Concomitant tibial shaft and posterior malleolar fractures can be readily diagnosed from plain radiographs: A retrospective study

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Abstract

Background: Concomitant tibial shaft and posterior malleolar fractures (PMFs) are often encountered in clinical settings. Plain films were reviewed for concomitant PMF, and fracture patterns were analyzed by focusing on the integrity of the fibula and the location of the fibular fracture.
Methods: A retrospective review of patients who presented with tibial shaft fractures between January 2005 and January 2010 was performed. Patients were included if they were at least 18 years of age and had a tibial diaphyseal fracture. Exclusion criteria were age less than 18 years, previous surgery on the same leg, and pathological fractures. Medical records were reviewed for information on injury mechanisms. Pre- and post-operative radiographs were analyzed for PMFs, tibial fracture pattern, fibular integrity, fibular fracture pattern, treatment type, and time to fracture union. Descriptive statistical tests were used.
Results: Among 240 patients, there were 20 cases (15 male and 5 female) of concomitant PMF, all detected in lateral radiograph views. The incidence of PMF was 8.3%. Most patients had a motorcycle injury ($n = 15$, 75%). Distal tibia spiral fracture was the most common fracture pattern (85%) and there was no proximal tibia fracture (0%). Combined fibular fractures were found in 17 patients (85%). There were nine proximal fibular fractures (45%). Intact fibulas were found in three patients (15%). Only one PMF was treated with screw fixation. All PMFs showed radiographic evidence of healing within 5 months post-operatively.
Conclusion: We recommend careful radiographic examination to evaluate PMF, especially in patients with distal tibial spiral fractures combined with proximal fibular fractures or intact fibulas.

Keywords: posterior malleolar fracture; proximal fibular fracture; tibial shaft fracture

1. Introduction

Concomitant posterior malleolar fracture (PMF) and tibial shaft fractures often occur in clinical practice and have been reported in several series.[1−4] If neglected, PMF may lead to iatrogenic displacement during treatment of tibial shaft fractures.[5] Tibial fracture patterns are described as spiral,[1] close oblique,[2] and of low energy.[3] The incidence detected on radiography ranges from 3.9% to 25%.[1−4] With computed tomography (CT) scans or magnetic resonance imaging (MRI), a much higher incidence of 88.2% has been reported,[4] prompting a recommendation for routine CT scanning to evaluate possible PMFs. However, the description of the fibula integrity and fracture pattern in these studies was limited to "at different levels".[1,4] We performed a retrospective review of concomitant PMFs and tibial shaft fractures to further investigate the status of fibular injury. We propose that identification of additional fibular characteristics might help in diagnosing concomitant PMF in tibial shaft fractures.

The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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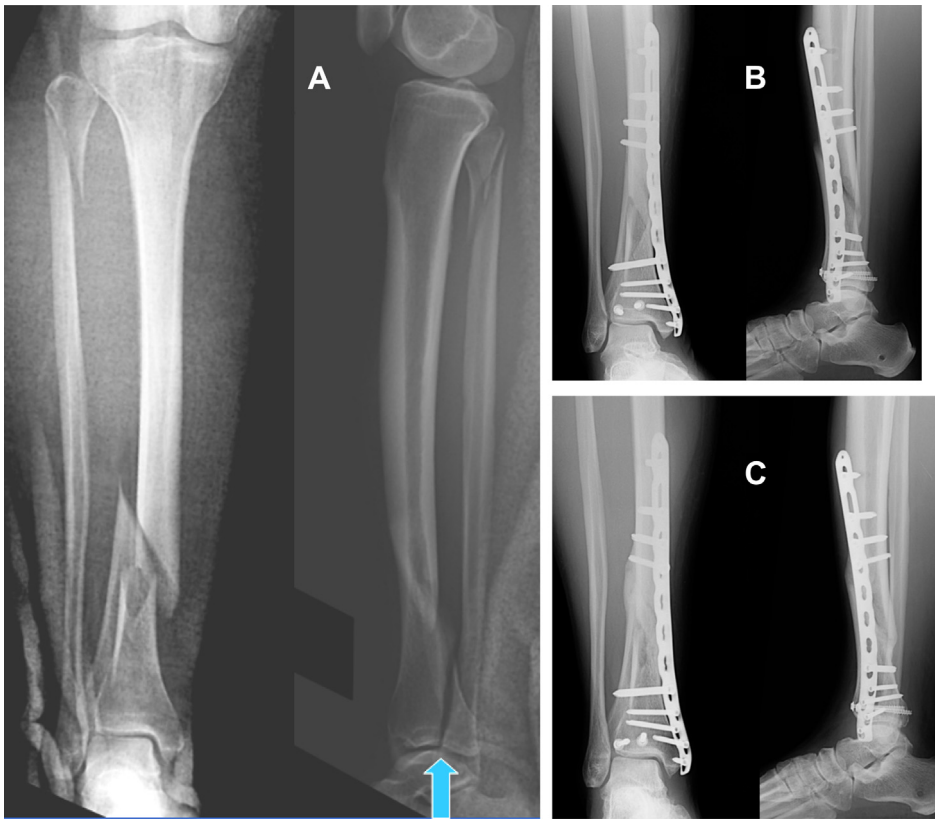

Fig. 1. (A) Plain films for a 49-year-old female who suffered a motorcycle accident leading to a right tibia shaft fracture with concomitant posterior malleolar fracture (PMF). There was also a proximal fibula fracture. Note the displaced PMF fragment on the lateral view (arrow). (B) The patient underwent open reduction and internal fixation with a plate and screws. The PMF was reduced and then fixed with two screws. The proximal fibula fracture was treated nonsurgically. (C) Five months after the surgery, solid union of both the tibia shaft fracture and the PMF was observed. The proximal fibula fracture was also healed.

2. Methods

A retrospective chart review of patients with tibial shaft fractures between January 2005 and January 2010 was performed. Patients were included if they were at least 18 years old and had a tibial diaphyseal fracture. Exclusion criteria were age less than 18 years, previous surgery on the same leg, and pathological fractures. Medical records were

Table 1
Detailed information for patients with concomitant tibia shaft fracture and posterior malleolar fracture.

No.	Sex	Age (y)	Side	Cause	Tibia fracture	Fibula fracture	Treatment
1	Male	32	Left	Motorcycle accident	Distal, spiral	Intact	Cast
2	Male	49	Right	Fall from stairs	Distal, spiral	Proximal, spiral	ILN
3	Female	47	Right	Motorcycle accident	Distal, spiral	Distal, spiral	ILN + plate
4	Female	49	Right	Fall from stairs	Middle, spiral	Distal, spiral	ILN + plate
5	Male	39	Right	Slippage	Distal, spiral	Proximal, spiral	ILN
6	Male	33	Right	Motorcycle accident	Distal, spiral	Intact	Plate
7	Male	20	Right	Motorcycle accident	Distal, spiral	Intact	Plate
8	Male	24	Left	Motorcycle accident	Distal, spiral	Proximal, spiral	Plate
9	Male	44	Left	Motorcycle accident	Distal, spiral	Proximal, spiral	ILN
10	Male	61	Left	Motorcycle accident	Distal, spiral	Proximal, spiral	ILN
11	Male	42	Left	Skiing	Distal, spiral	Middle, spiral	ILN
12	Female	49	Right	Motorcycle accident	Distal, spiral	Proximal, spiral	Plate
13	Male	52	Right	Motorcycle accident	Distal, spiral	Distal, spiral	ESF
14	Female	33	Left	Motorcycle accident	Distal, spiral	Middle, spiral	Wires + screws
15	Male	42	Left	Motorcycle accident	Distal, spiral	Proximal, spiral	ILN
16	Male	51	Right	Motorcycle accident	Distal, spiral	Proximal, spiral	ESF
17	Male	38	Right	Motorcycle accident	Distal, spiral	Distal, spiral	Plate
18	Male	57	Right	Slippage	Distal, spiral	Proximal, spiral	ILN
19	Male	54	Left	Motorcycle accident	Distal, spiral	Distal, spiral	Plate
20	Female	27	Left	Motorcycle accident	Distal, not spiral	Distal, not spiral	ESF

ESF = extraskeletal fixation; ILN = interlocking nail.

Fig. 2. (A) A 20-year-old man suffered from a right tibia shaft fracture after a motorcycle accident. The fibula was intact despite a comminuted fracture of the tibia. (B) A posterior malleolar fracture (PMF) became obvious in a enlarged lateral X-ray view focusing on the ankle region. The patient underwent open reduction and internal fixation with screws and wires for the tibia shaft fracture. The small PMF was treated nonsurgically. (C) Four months after the surgery, solid union of both the tibia shaft fracture and the PMF was evident on plain films.

reviewed for injury mechanisms. Pre- and post-operative radiographs were analyzed for PMF, tibial fracture pattern, fibular integrity, fibular fracture pattern, treatment type, and time to fracture union.

The fracture patterns were classified according to their location on the bone and morphology. A fracture was classified as proximal, middle, or distal according to the fracture site in relation to the length of the entire bone. For example, a fibula fracture was defined as proximal when the distance between the fracture site and the proximal end of the fibula was less than one-third of the total fibula length. Spiral fracture classification depends on the fracture length and the bone diameter

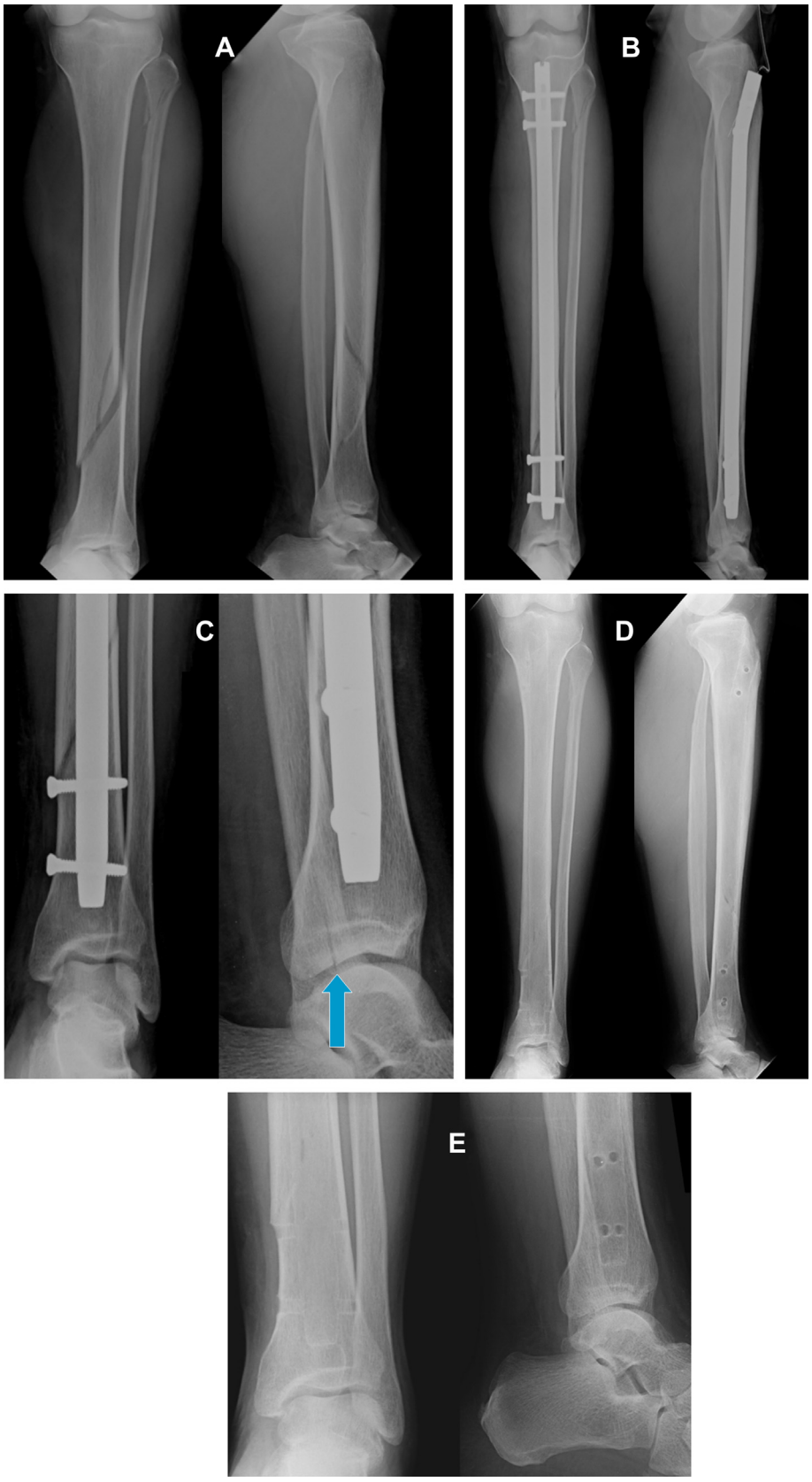

Fig. 3. (A) A 34-year-old male suffered from a left tibia shaft fracture after a motorcycle accident. There was also a proximal fibula fracture and posterior malleolar fracture (PMF), which were not as evident on initial plain films. (B) The patient underwent interlocking nail fixation for the tibia shaft fracture. (C) The PMF became more evident in a post-operative lateral view. The PMF was protected using a short leg cast. The proximal fibula fracture was treated nonsurgically. (D) One year after the operation, the nail was removed. Solid union of both the tibia shaft fracture and the proximal fibular fracture was evident from plain films. (E) An ankle lateral X-ray shows that the PMF healed without further displacement.

Table 2
Summary of fracture patterns for 20 patients with concomitant tibia shaft fracture and posterior malleolar fracture.

Fracture pattern	Patients
Tibia	
Spiral	19 (95)
Distal	19 (95)
Distal spiral	18 (90)
Middle	1 (5)
Proximal	0 (0)
Fibula	
Spiral	17 (85)
Proximal	9 (45)
Distal	6 (30)
Same zone as tibia fracture	5 (25)
Intact (no fracture)	3 (15)

Data are presented as *n* (%).

at the level of the fracture. For a fracture length more than 1.5 times the diameter, the fracture was classified as spiral. For example, the fracture pattern in Fig. 1A was described as a distal tibia spiral fracture with concomitant PMF and a proximal fibula spiral fracture.

3. Results

Of 240 patients with tibial shaft fractures, 20 (15 male and 5 female) had concomitant PMF. The incidence was 8.3%. There was only one displaced PMF with a fragment size of approximately 50% of the distal tibial plafond. The remaining PMF fragments were minimally or not displaced with small fragment sizes (<25%) on the initial radiographs. The majority of injuries were caused by motorcycle accidents ($n = 15$, 75%). Patient demographic data are shown in Table 1.

Of 20 patients with PMFs, there were 19 tibial spiral fractures (95%) and 19 distal tibia fractures (95%). A distal spiral fracture was the most common tibia fracture pattern ($n = 18$, 90%; Figs. 1–3A). Other less common fracture patterns included nonspiral tibia fracture (5%) and middle-third location (5%). No concomitant PMF was found in patients with a proximal tibia fracture.

Seventeen of the 20 patients (85%) had fibular fractures and the remaining three (15%) had intact fibulas (Fig. 2A). Spiral fracture was the most common fibula fracture pattern, since all 17 fibular fractures were spiral. There were nine proximal (45%), six distal (lateral malleolar) (30%), and two middle fibular fractures (10%). Some 25% of patients ($n = 5$, Patients 3, 13, 17, 19, and 20) had a fibular fracture at the same level as the tibial shaft fracture. The frequency of these fracture patterns is summarized in Table 2.

Tibial shaft fractures were treated with interlocking nails ($n = 9$, 45%), plates ($n = 6$, 30%), external fixation ($n = 3$, 15%), screws and wires ($n = 1$, 5%), and a cast ($n = 1$, 5%). Only one PMF was fixed with screws (Patient 12, Fig. 1B,C). There was no further displacement of the PMF fragments in all patients (Figs. 1C, 2C, and 3E). All shaft fractures and PMFs healed within 5 months post-operatively.

4. Discussion

By identifying fracture combinations, further displacement of PMF fragments, either intra-operatively during intramedullary nailing[5] or post-operatively due to inadequate protection, can be prevented. The incidence of concomitant tibial shaft fracture and PMF in our study was 8.3%, which is comparable to that in previous studies.[1–4] A literature review of concomitant tibial shaft fracture and PMF is presented in Table 3.[1–4]

The most important diagnostic component in our retrospective review was a careful radiologic evaluation, specifically searching for PMF fragments and enlarging the lateral view using a digital imaging system (Figs. 2B and 3C). PMF fragments can easily be detected in combination with an adjacent distal fibular fracture, but may be overlooked when occurring in conjunction with a proximal fibular fracture or an intact fibula owing to the obvious tibial shaft fracture. In addition, most PMF fragments are typically only minimally or not displaced (19/20 in our series). Therefore, detection of concomitant PMF fragments depends on a high degree of vigilance when examining lateral radiographic views.

To aid in the diagnosis of PMF fragments, routine ankle radiography has been suggested for low-energy distal tibia spiral fractures.[3] In addition, routine CT scanning and MRI have been recommended for detection of PMF fragments.[4] In our study, we analyzed fracture patterns to ensure detection of any concomitant fractures. Future research directions include investigation of possible risk factors for concomitant PMF.

Distal tibial spiral fracture was the most common fracture pattern in our study (85%). An association between distal tibial spiral fracture and PMF has been reported in several studies, all of which suggested a rotational mechanism as the cause of this fracture pattern.[2,3,6]

Table 3
Summary of published studies on concomitant tibia shaft and posterior malleolar fracture.

Incidence (%)	Fracture pattern	Mechanism	Detection	Ref.
0.9	All fractures		Ankle radiography	1
3.9	Spiral fractures			
11.5	Oblique and close	Rotational force, low energy	Ankle radiography	2
25	Distal tibia spiral fracture	Low energy	Ankle radiography	3
9.7	Junction, inferior apex always medial	Low energy, fall from low level	Ankle radiography	4
88.2	Fibula fracture, not same level	Direct low-energy impact, bicycle	CT & MRI	

CT = computed tomography; MRI = magnetic resonance imaging.

Proximal fibular fractures, also known as stage IV or V Maisonneuve fractures,[7] were observed in nine (45%) patients with concomitant PMF, suggesting a strong external rotation force[7] and implied ankle injury.[8] An arthroscopic study revealed associated ligament injury (including anterior tibiofibular ligament, interosseous ligament, and deltoid ligament) and proposed that a Maisonneuve fracture could be a pronation external rotation-type injury according to the Lauge−Hansen classification.[9] However, in classical Lauge−Hansen pronation external rotation fractures, PMFs occur in stage IV after medial malleolar fracture, or after a deltoid ligament rupture (Stage I) and a high fibular fracture (Stage III). Such findings were not consistently observed in these nine patients. This unique fracture pattern has also been proposed.[10]

Association with a fibula fracture proximal to the tibia level was observed in 95% of patients in one study.[6] In our study, the proportion of proximal fibular fractures was lower ($n = 9$, 45%), and six patients had distal fibular fractures (30%). Furthermore, five patients (20%) in our study had a fibular fracture in the same zone as the tibia fracture. This suggests that a fibular fracture may not always occur at a different level in conjunction with PMF. Although the exact fracture mechanism remains unknown, we believe that this difference might be caused by different rotation mechanisms. We also recommend careful examination of the ankle both clinically and radiologically to avoid neglected PMFs, especially if there are associated proximal fibular fractures.

Association between a tibial shaft fracture with an intact fibula and ankle injury has also been suggested.[11,12] PMFs may also be overlooked in this fracture combination owing to the obvious tibial shaft fracture on initial radiography. In our series, three patients (15%) with concomitant tibial shaft fracture and PMF had an intact fibula. Again, careful radiologic examination in this fracture combination can ensure that PMFs are not overlooked.

There is limited evidence regarding the optimal treatment of tibial shaft fractures with concomitant PMFs. It has been reported that intramedullary nailing for shaft fractures causes iatrogenic displacement.[1,5] Once displaced, the nail also increased the fixation difficulty owing to obliteration of the screw placement.[3,4] In our study, nine patients (45%) treated with intramedullary nailing achieved appropriate union of both the shaft fractures and PMF without any such complications. We believe that intramedullary nailing is an appropriate surgical option.

Treatment of PMF remains controversial. A study with 13-year follow-up found no evidence requiring fixation of PMF fragments smaller than 25%.[13] Another study revealed that joint congruity was a significant prognostic factor, independent of fixation.[14] The incidence of initial displacement of PMF fragment was reported as 3.3%[4] and 33%[3] in two different studies. In our study, only one patient required screw fixation for an initially displaced PMF fragment (5%). Nineteen (95%) patients underwent conservative treatment for nondisplaced or minimally displaced PMFs. All PMFs healed without any complications. In our opinion, fixation of small-sized PMFs with a congruent ankle joint is not always necessary initially. With regular follow-up, close observation, and protective weight-bearing, conservative treatment remains a viable option.

In conclusion, we recommend particular care when treating a distal tibial spiral fracture, especially with a proximal fibular fracture or intact fibula, as a PMF can easily be overlooked. These additional findings suggest a mechanism of rotational force associated with ankle injuries, including PMFs. Small-sized PMF fragments with congruent ankle joints may be treated conservatively and may benefit from intramedullary nailing as required.

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